DISCUSSION

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RESULTS

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Recently, heterosis used for production of large yield through increasing both of quantity and quality. Therefore, heterosis in F_1 generations must be determined. Also the classification of the parents acheived according to their ability to produce valuable hybrids.

Accordingly, the present investigation was carried to study heterosis, combining ability and correlations of some parental wheat varieties/lines, from different locations, by means of diallel cross analysis.

The results obtained were classified into three parts: i.e heterosis, combining ability and association analysis.

1. Heterosis:

Results concerning analysis of variances found in Table (5) showed differences among the studied genotypes in all characters.

Parents mean squares of all characters were highly significant showing the differences between the parental lines.

The mean performance of the six parents are found in Table (6). Pavon was the best one of the tested parents in earliness and gave the second highest value of spike length. However it shawed the lowest

Table (5): Analysis of variance for the studied traits from a diallel cross in wheat.

Source of Variation	DF	Heading Date	Plant Height	No. of Tiller	No. of Spikes /plant	Spike Length / cm	No.of Spikl Spike	No. of Kernel /spike	1000 Kernels weight	Total plant weight	Yield grains /plant
Replicates	3	0.553	0.254	0.529	0.171	0.467	0.032	0.163	0.519	0.63	0.101
Genotypes	20	181.314**	304.038**	43.876**	33.341**	19.316**	9.003**	44.541**	228.938**	876.66**	253.933**
Error	60	0.265	0.337	0.454	0.171	0.209	0.027	0.287	0.769	0.25	0.354

* and ** : Significantly different at probability level of 0.05 and 0.01, respectively.

Table (6): Mean of Six wheat varieties and their F_1 hybrids from a half diallel cross.

Characters / Genotypes	Head. Date	Plan Hei-ght	Number of Ti-llers	No. of Spikes /plant	Spike length cm	No. of Spikel /spike	No. of Kernels per Sp.	1000 Kernels Weight	Total plant weight	Yield grains per pl.
Giza 157	98.23	109.38	11.04	17.54	11.70	22.62	45.02	40.63	112.50	36.07
Pavon	87.69	105.75	8.23	9.93	13.83	21.81	40.87	35.61	103.81	32.32
City stra-ws	97.54	118.25	14.09	13.44	12.69	22.00	45.38	50.64	116.63	38.14
Hatry	109.39	124.50	18.57	16.48	10.28	20.90	42.30	29.09	109.94	30.63
Floranae	108.76	122.00	20.42	12.96	10.13	20.88	42.10	29.50	105.69	29.75
Mario	95.71	104.25	15.45	18.77	15.94	22.56	44.63	44.54	123.56	33.73
P1 x P2	85.16	107.88	12.19	13.93	11.91	22.46	47.20	47.30	90.31	37.98
P1 x P3	92.00	120.25	11.94	16.69	12.59	22.91	45.36	45.82	109.19	28.09
P1 x P4	101.18	129.75	14.74	20.43	08.57	18.64	45.42	34.05	90.88	16.88
P1 x P5	102.84	130.75	16.80	18.45	09.96	19.24	42.06	40.38	87.56	22.14
P1 x P6	90.07	109.88	15.24	20.71	14.85	22.29	48.38	51.14	115.44	41.64
P2 x P3	86.70	120.50	10.80	14.59	10.58	22.25	45.22	37.87	85.44	36.09
P2 x P4	97.47	125.25	14.79	13.86	09.18	19.23	36.56	31.76	80.44	19.86
P2 x P5	100.76	124.88	18.21	11.96	11.69	20.10	38.79	32.65	77.25	23.51
p2 x p6	92.00	110.38	16.68	15.63	13.83	23.11	48.19	39.08	100.75	43.59
p3 x p4	98.60	131.88	20.90	18.15	10.71	18.19	39.76	48.20	85.06	25.64
p3 x P5	99.76	124.89	19.65	11.60	11.35	20.16	43.00	46.36	80.19	30.56
P3 x P6	96.56	119.83	17.19	14.95	13.94	22.95	47.91	54.73	109.69	37.88
P4 x P5	104.85	130.50	18.10	14.95	07.63	20.76	40.47	31.91	74.88	17.51
P4 x P6	102.70	125.25	17.96	18.06	14.18	20.81	40.62	39.70	90.38	23.69
P5 x P6	101.13	124.50	17.94	16.04	13.87	21.01	39.86	42.46	83.88	21.77

** and **: Significantly different at probability level at 0.05 and 0.01, respectively.

Table (7): Percentage of heterosis over better parents (B.P.) for all the studied crosses.

Characters / Genotypes	Head Date	Plant Heigh	Number of Ti-llers	No. of Spikes /plant	Spike length cm	No. of Spikel /spike	No. of Kernels per Sp.	1000 Kernel Weight	Total plant weight	Yield grains per pl
P1 x P2	-2.89	-1.37	10.42	-20.58	-13.88	-0.71	4.820	16.42	-19.72	5.30
P1 x P3	-5.68	1.69	-15.26	-4.85	-0.79	1.28	-0.04	-9.52	-6.38	-26.35
P1 x P4	3.00	4.22	-20.62	16.48	-26.75	-17.60	0.89	-16.19	-19.22	-53.20
P1 x P5	4.69	7.17	-17.73	5.19	-14.87	-13.26	-6.57	-0.62	-22.17	-38.62
P1 x P6	-5.89	0.46	-1.36	10.34	-6.84	-1.46	7.42	14.82	-6.57	15.44
P2 x P3	-1.13	1.90	-23.35	8.56	-23.50	1.14	-0.35	-25.22	-26.74	-5.37
P2 x P4	11.15	0.60	-20.36	-15.90	-33.62	-11.83	-13.16	-10.81	-26.83	-38.55
P2 x P5	14.90	2.36	-10.82	-7.72	-15.47	-7.84	-7.86	-8.31	-26.91	-27.26
P2 x P6	4.92	4.38	7.96	-16.73	-13.24	2.44	7.989	-12.26	-18.46	29.23
P3 x P4	1.09	5.94	12.55	10.13	-15.60	-17.32	-12.38	-4.87	-27.07	-32.77
P3 x P5	2.28	2.37	-3.77	-10.49	-10.56	-8.36	-5.24	-8.46	-31.24	-19.87
P3 x P6	96.56	0.89	1.34	11.26	-20.35	-12.55	5.58	8.08	11.23	-0.68
P4 x P5	-3.60	4.82	-11.36	-9.28	-25.78	-0.67	-4.33	8.17	-31.84	-42.83
P4 x P6	7.30	0.60	- 3.28	-3.78	-11.04	-7.76	-8.98	-10.87	-26.85	-29.77
P5 x P6	5.66	2.05	- 0.12	-14.54	-12.99	-6.87	-10.69	-4.86	-32.11	-35.46

** and **: Significantly differed at probability level at 0.05 and 0.01, respectively.

values for plant height, number of tillers per plant, number of spikes per plant and number of kernels per spike. Giza 157 gave the highest value in number of spikelets per spike. Hatry expressed its superiority in plant height, although it exhibited the lowest value in 1000-kernel weight per plant. Floranae shawed the highest value for number of tillers per plant. However it gave the lowest values for spike length and yield of grains per plant. The variety Mario significantly suppressed all the test parents in number of spikes per plant, spike length and total plant weight and gave the second highest value of number of spikelets per spike and 1000-kernel weight per plant the variety. City straws shawed the highest values in number of kernels per spike, 1000-kernel weight and yield of grains per plant. It gave the second highest value of total plant weight.

Hybrids mean squares were highly significant for all characters (Table 7). The mean performances of the tested 15 hybrids are found in Table (8). The mean values were significantly higher than the parental means for all the studied characters except heading date.

Heterosis, which expressed as the percentage deviation of F_1 mean performance from the better parent average value, for all the studied characters are found in Table (9). Average values of heterosis were estimated for the studied Heading date, plant height, number of tillers, number of spikes per plant,number of spikelets per spike, 1000-kernel weight, total plant weight and yield grains per plant.

Table (8): Analysis of variance for combining ability for the studied characters.

Source of Variation	D F	Heading Date	Plant Height	No. of Tiller	No. of Spikes /plant	Spike Length / cm	No.of Spikl Spike	No. of Kernel /spike	1000 Kernels weight	Total plant weight	Yield grains /plant
G.C.A.	5	154.074	206.399	33.133	26.291	15.165	4.358	23.242	174.768	340.91	121.527
S.C.A.	15	9.080	32.546	3.581	2.349	1.384	1.548	7.099	18.057	178.59	44.135
Error	60	0.066	0.084	0.113	0.043	0.052	0.006	0.072	0.192	0.06	0.089
GCA/SCA		16.969	6.342	9.252	11.188	10.961	2.814	3.274	9.679	1.91	2.754

* and ** : Significantly different at probability level of 0.05 and 0.01, respectively.

Number of days to heading showed that the hybrids tended to be near the earliness. Earliness is needed in Egypt in order to escape from some fungal diseases like rusts. Most of the hybrids reached heading earlier than their parental means. For this character eight hybrids, i.e P_1 x P_2, p_1 x P_3, P_1 x P_6, P_2 x P_3 and P_4 x P_5 revealed significantly negative heterosis is comparison to better parent and ranged from -1.13 to - 5.89 for the cross P_2 x P_3 and P_1 x P_6, respectively (Table 7). These results should be of great importance if the other characters like quantity and quality characters are superior. These results agreed with *Attia (1972), Bitzer and Fu (1972), Mani and Rao (1977) El-Shamarka (1980) and Hamada (1993).*

The crosses P_1 x P_2, P_1 x P_3, P_1 x P_6 and P_4 x P_5 were the earliest headings ones. Consequently, parents like Giza 157, Hatry and Floranae has the ability to transfer earliness to their offsprings.

All hybrids except P_1 x P_2 showed significant positive heterotic effects, for plant height in a range of 0.457 to 7.17% for P_1 x P_6 and P_1 P_5, respectively. These results revealed that Giza 157 and pavon could transfer tallness to their offspring. These results were in agreement with *Abd-El-Halim (1974),Ageez(1976) and El-Shamarka(1980),Mahdy(1988), Younis et al.(1988),Tamam (1989),Alkadoussi (1991) and Hamada (1993).*

Only one negative heterotic effect value was recorded in cross P_1 x P_2. Actually, tall wheat hybrids were not recommended since it should be susceptible to lodging especially after the use of irrigation and heavy application of fertilizers. Therefore, the most interesting hybrids showed be of short style *(Johanson and Schmidt, 1968).*

For tillering ability, the data showed that the hybrids tend to be of less tillering ability in comparison to their better parents. For this character eleven hybrids, i.e P_1 x P_3, P_1 x P_4,P_1 x P_5, P_1 x P_6, P_2 x P_3, x P_2 x P_4, P_2 x P_5, P_3 x P_5, P_4 x P_5, P_4 x P_6 and P_5 x P_6. These results revealed that the less tillering ability parents could tend to transfer this character to their, F_1 hybrids.

Only four positive heterotic effects were recorded in crosses; P_1 xP_2, P_2 x P_6, P_3 x P_4 and P_3 x P_6. These results indicated that the sharing better parents in such crosses could transfer higher tillering ability to their offsprings, *Hammada (1993).*

Concerning spikes number per plant, the five crosses P_1 x P_4, P_1 x P_5, P_1 x P_6 ,P_2 x P_3 and P_3 x P_4 exhibited significant positive heterotic effects (from 5.19 to 16.48%). Whereas, the ten hybrids P_1 x P_2, P_1 x P_3, P_2 x P_4, P_2 x P_5, P_2 x P_6, P_3 x P_5, P_3 x P_6, P_4 x P_5, P_4 x P_6 and P_5 x P_6 showed significant negative heterotic effects as compared to the high number of spikes/plant parent (from - 3.78% to -23.35%). Positive heterotic effects relative to the better parent were also found by *Xu*

Table (9): Estimation of General combining ability (gi) for sex wheat parents for the studied characters.

Characters / Genotypes	Head Date	Plant Heigh	Number of Ti-llers	No. of Spikes /plant	Spike length cm	No. of Spikel /spike	No. of Kernels per Sp.	1000 Kernel Weight	Total plant weight	Yield grains per pl
Giza 157	-1.92	-2.86	-1.947	-1.947	-2.230	0.298	1.927	1.934	5.070	1.207
Pavon	-5.69	-4.97	-2.756	-2.483	0.214	0.296	-0.666	-3.074	-4.500	2.076
City Straws	-1.79	1.689	-0.002	-0.856	0.176	0.273	1.124	6.224	3.125	3.169
Hatri	5.07	6.453	1.556	1.088	-1.539	-1.098	-1.950	-5.085	-4.539	-5.261
Floranae	5.48	4.923	2.560	-1.350	-1.048	-0.672	-1.831	-3.965	-7.836	-4.261
Mario	-1.14	-5.24	0.590	1.654	2.426	0.903	1.397	3.965	8.680	3.354
SE (Gi)	0.083	0.094	0.1086	0.0663	0.0735	0.0265	0.0866	0.1414	0.0806	0.0959
SE (Gi-Gj)	0.129	0.145	0.1685	0.1034	0.1145	0.0412	0.13379	0.2193	0.1245	0.1487

** and * : Significantly differed at probability level at 0.05 and 0.01, respectively.

Fig (1): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Heading Date.

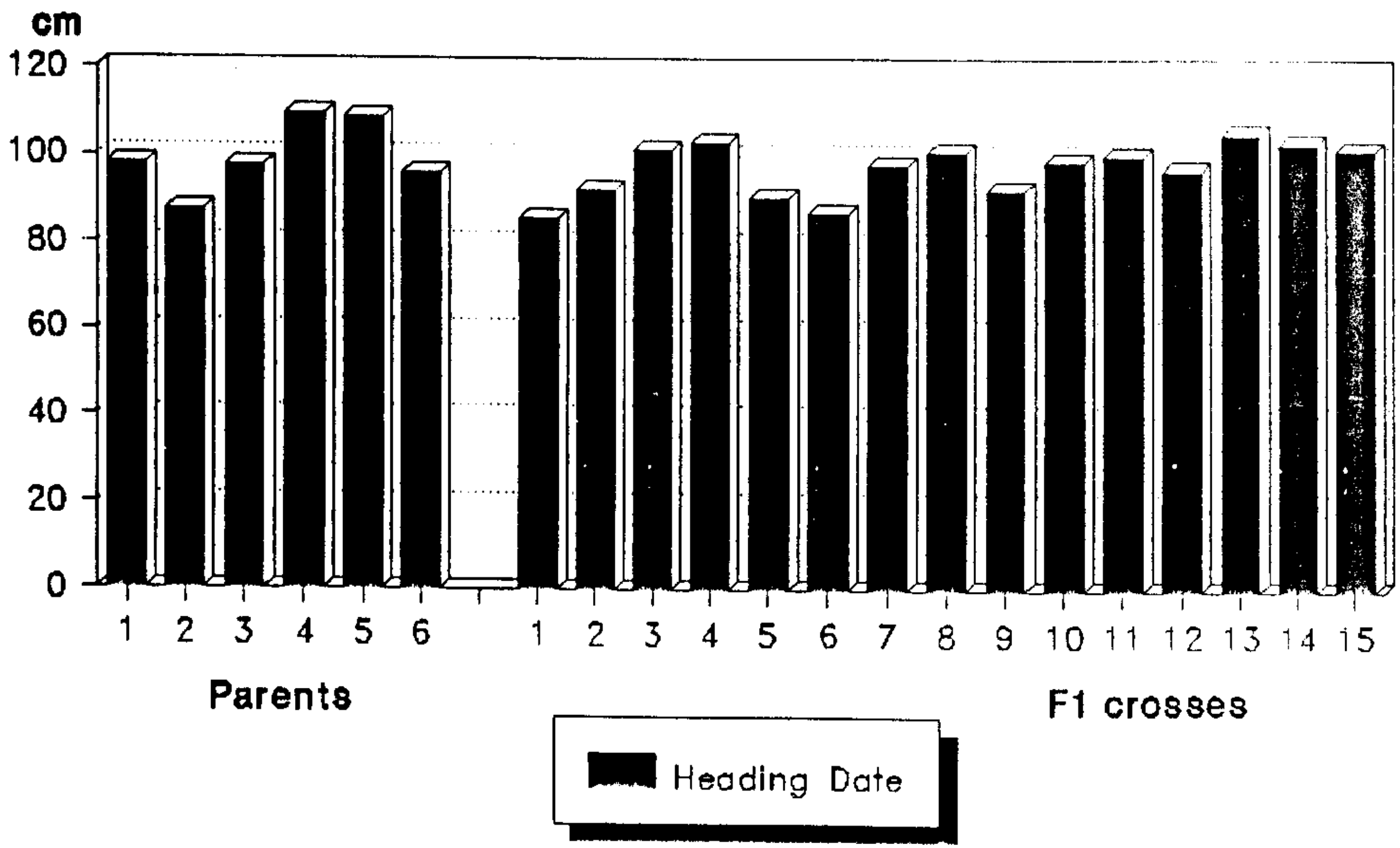


Fig (2): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Plant Height.

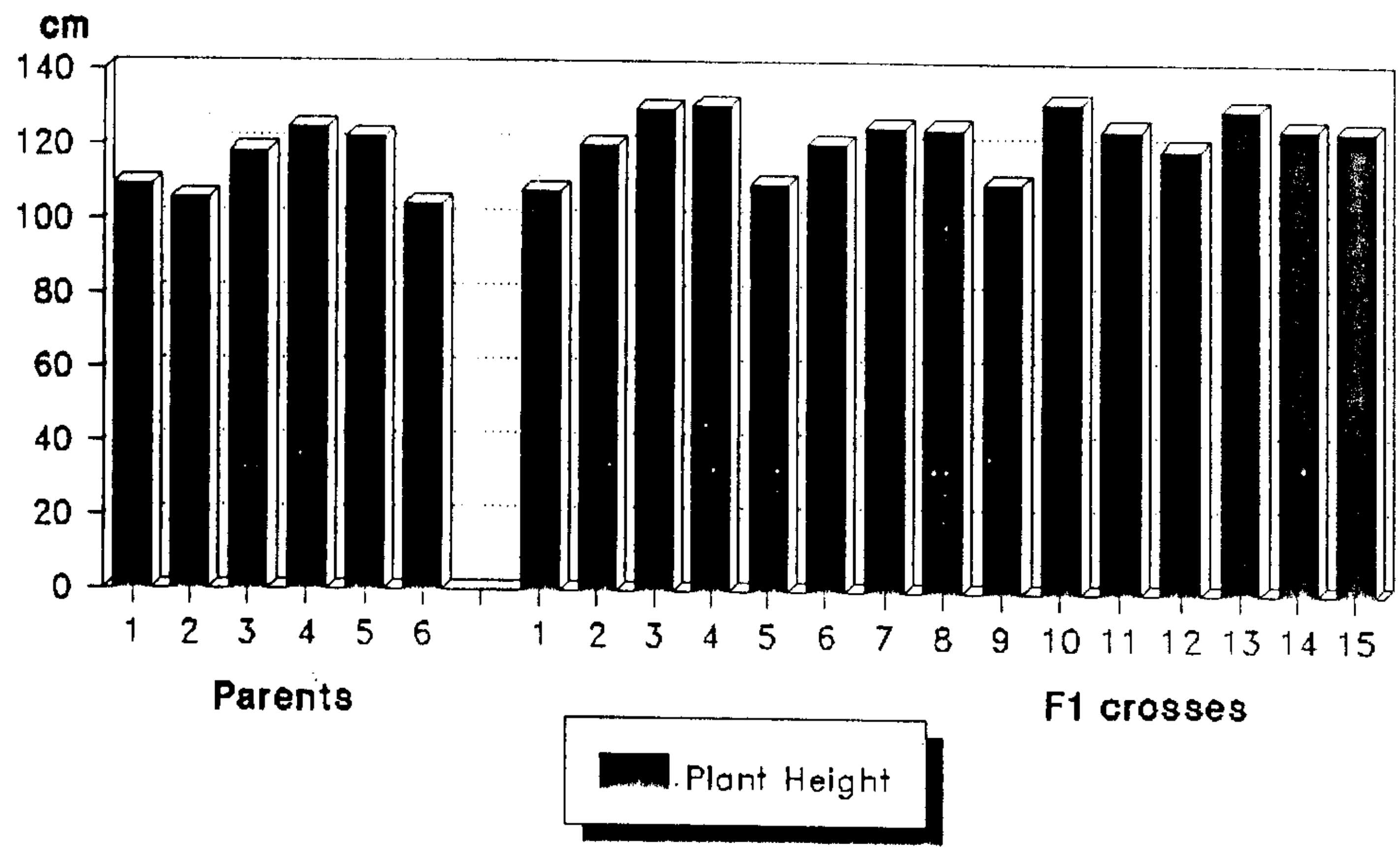


Fig (3): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Number of Tillers.

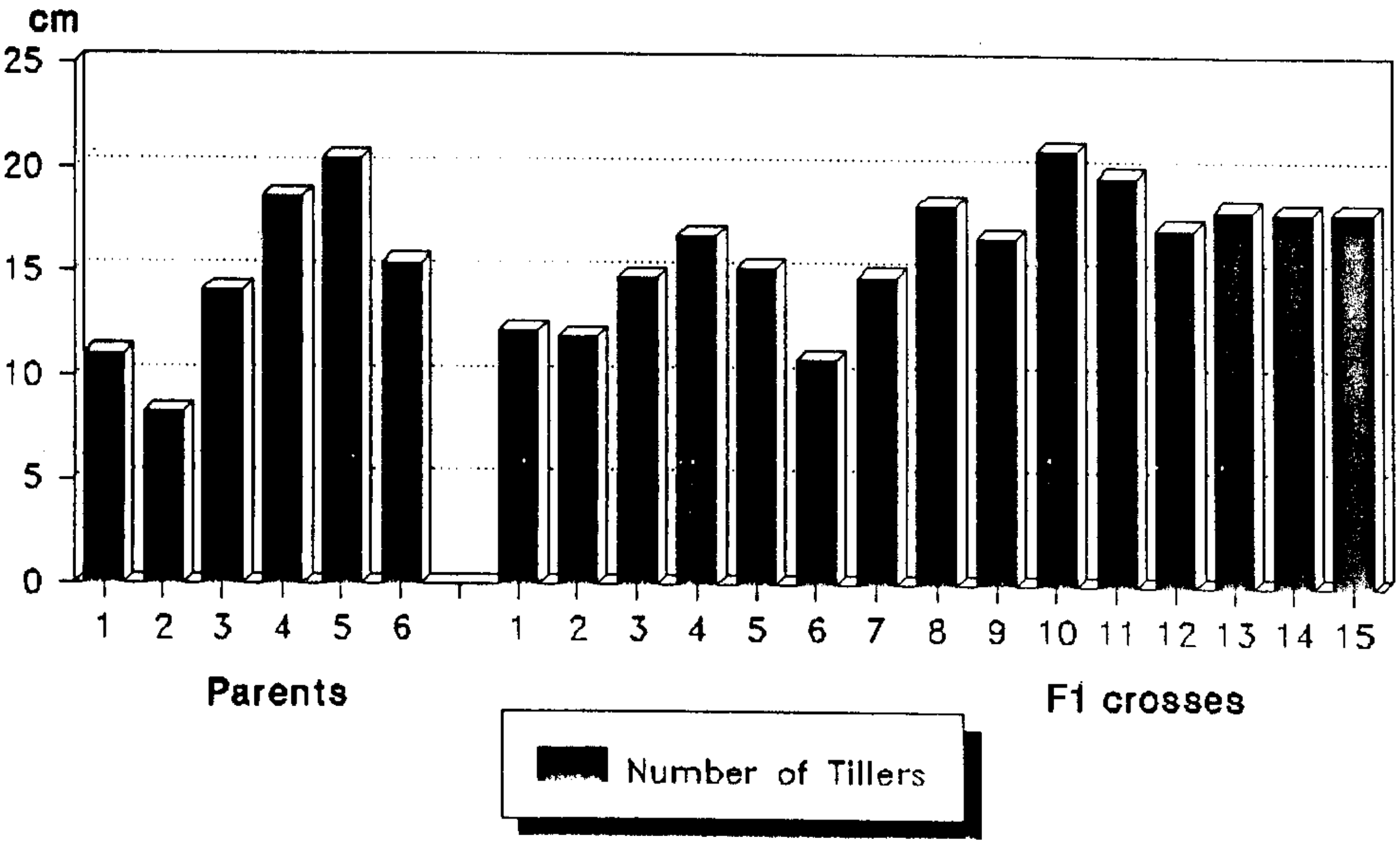


Fig (4): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Number of Sipkes per plant.

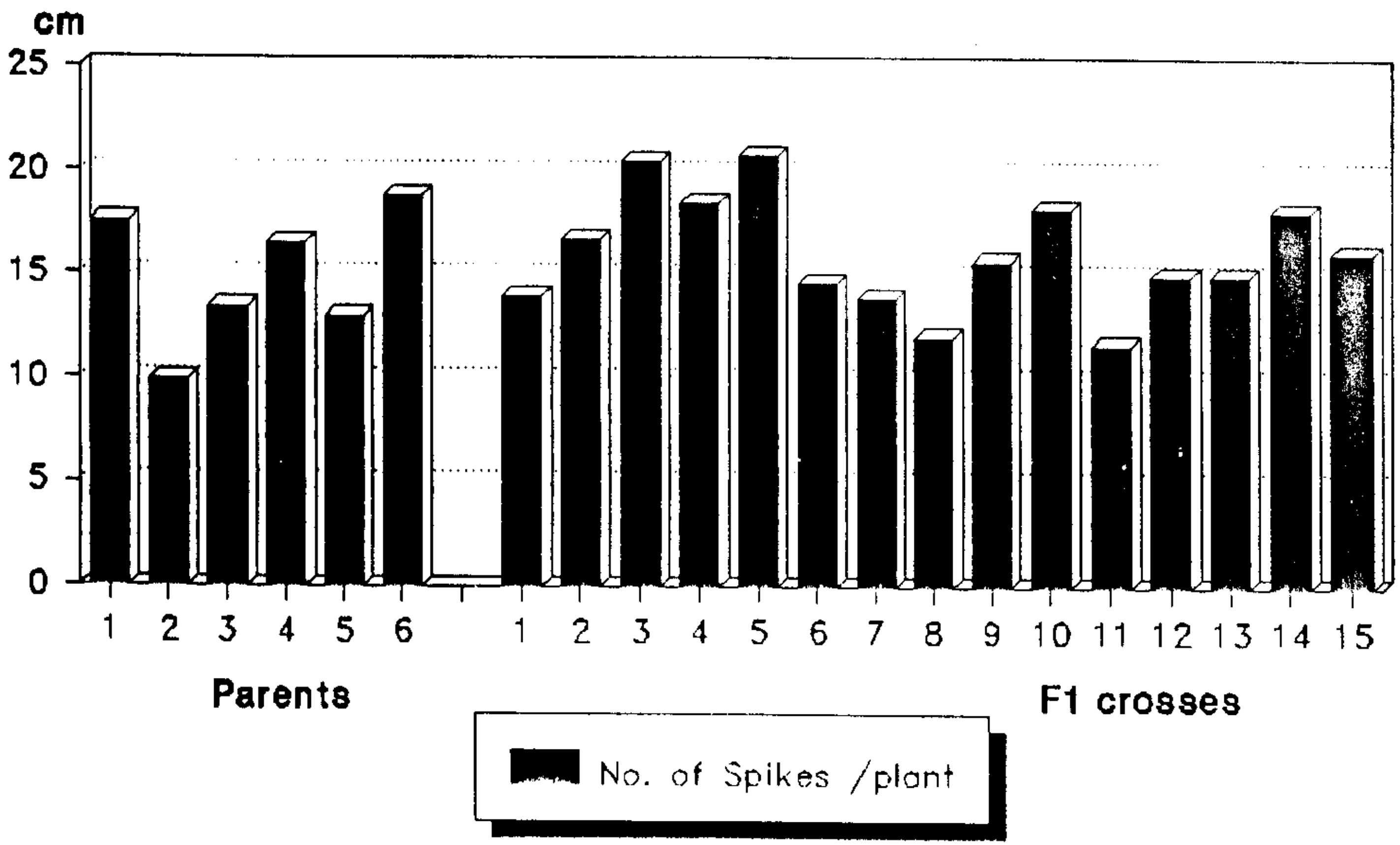


Fig (5): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Sipke length.

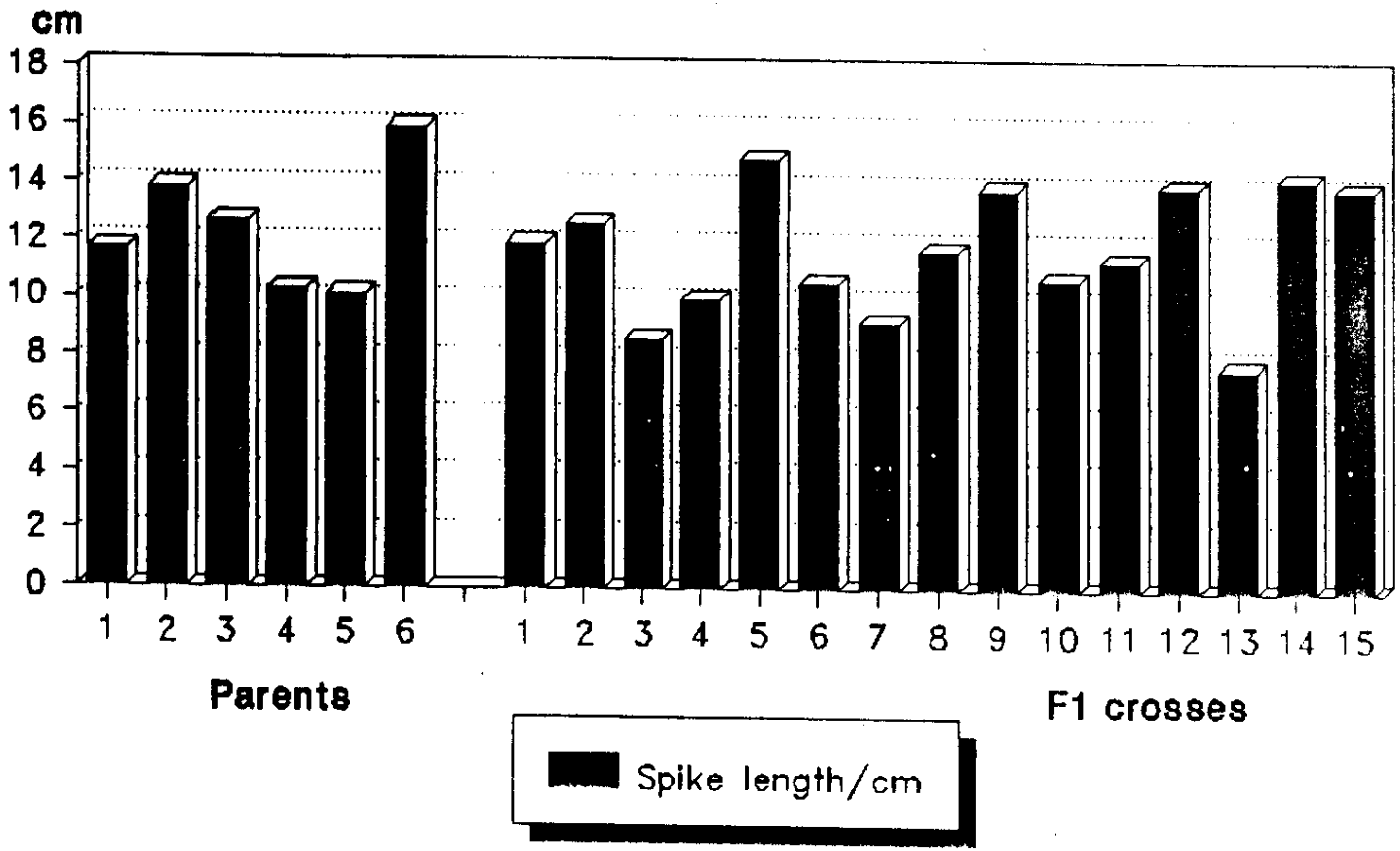


Fig (6): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Number of Spikelets per spike.

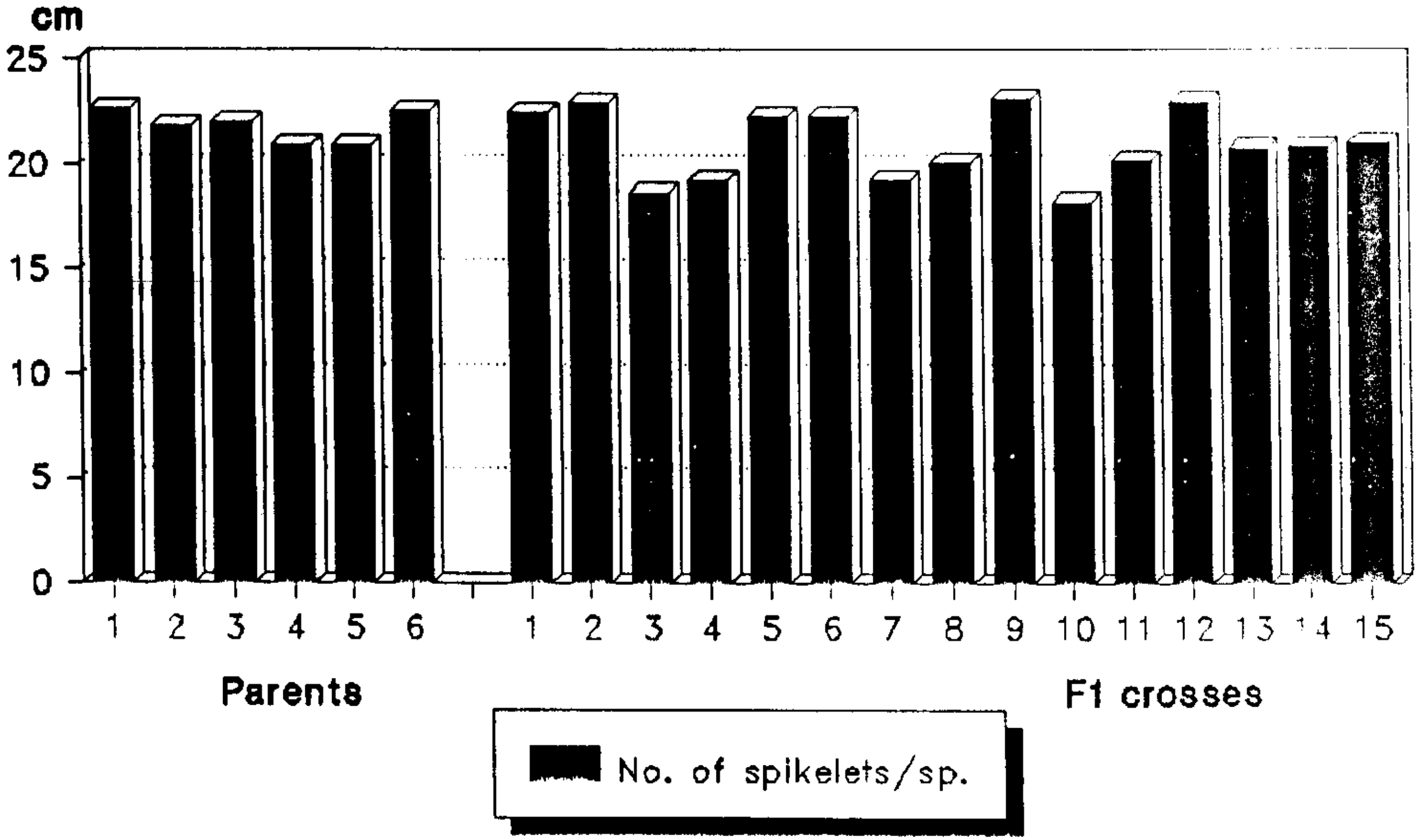


Fig (7): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Number of Kernels per Spike.

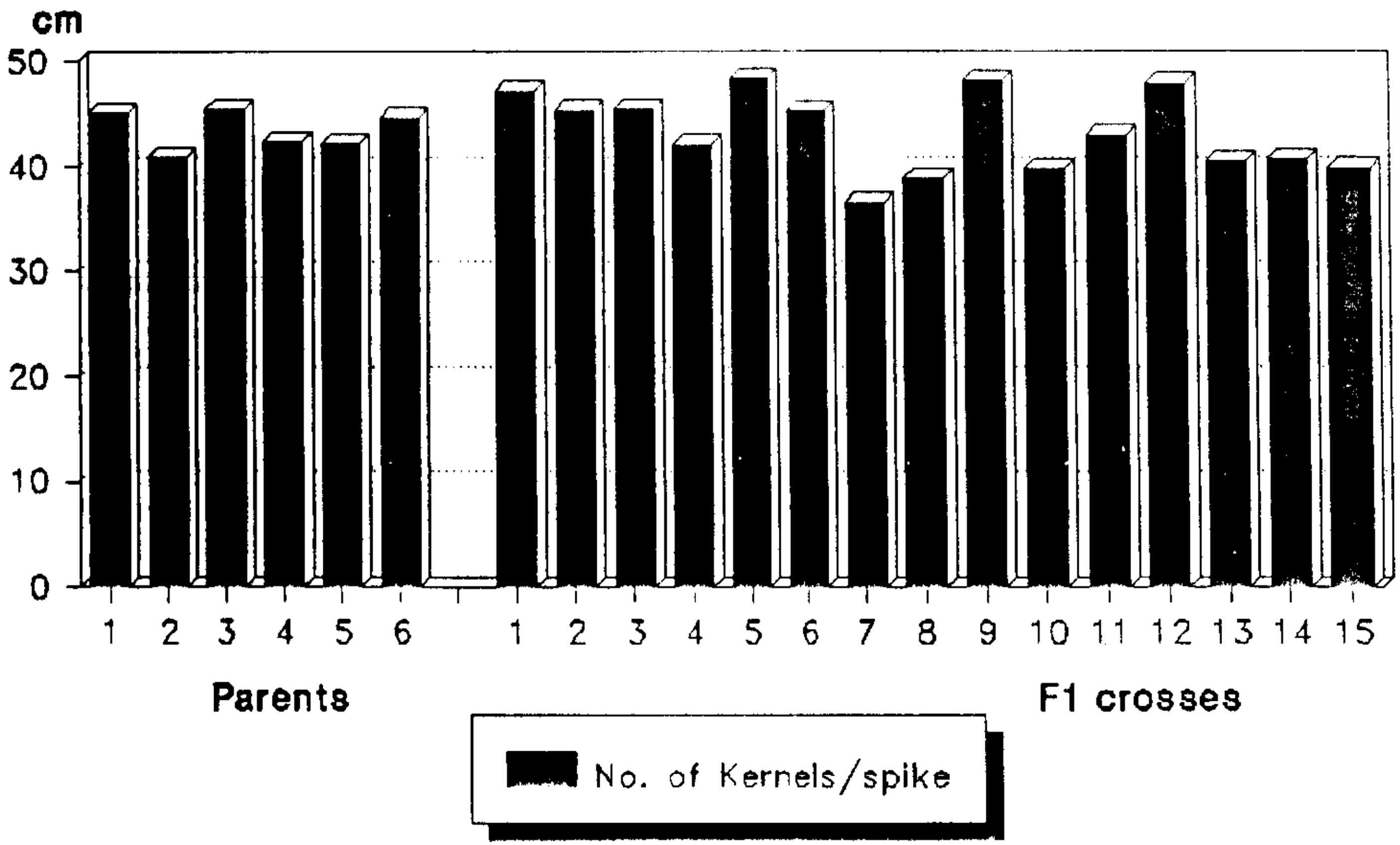


Fig (8): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for 1000 Kernels weight.

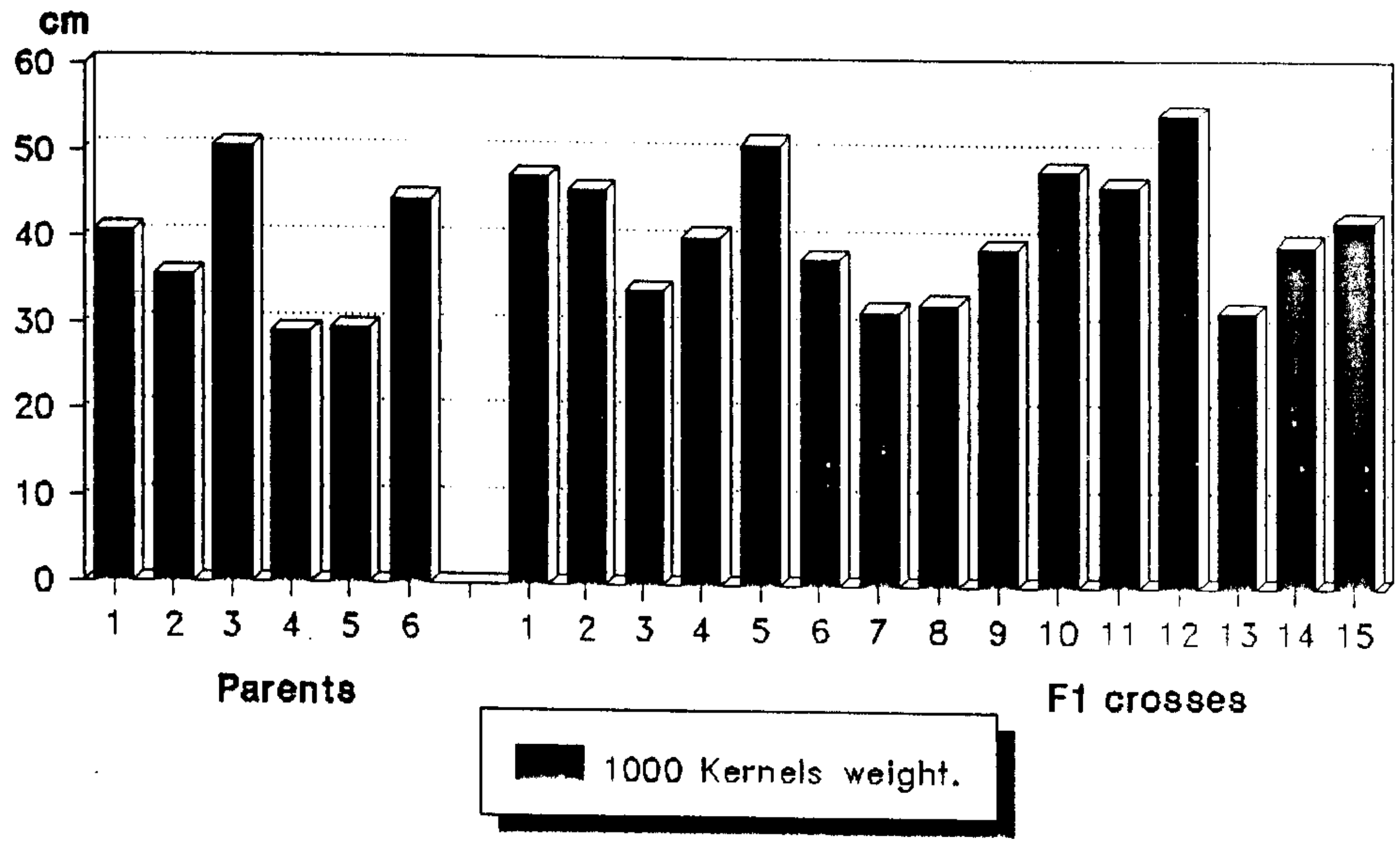


Fig (9): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Total plant weight.

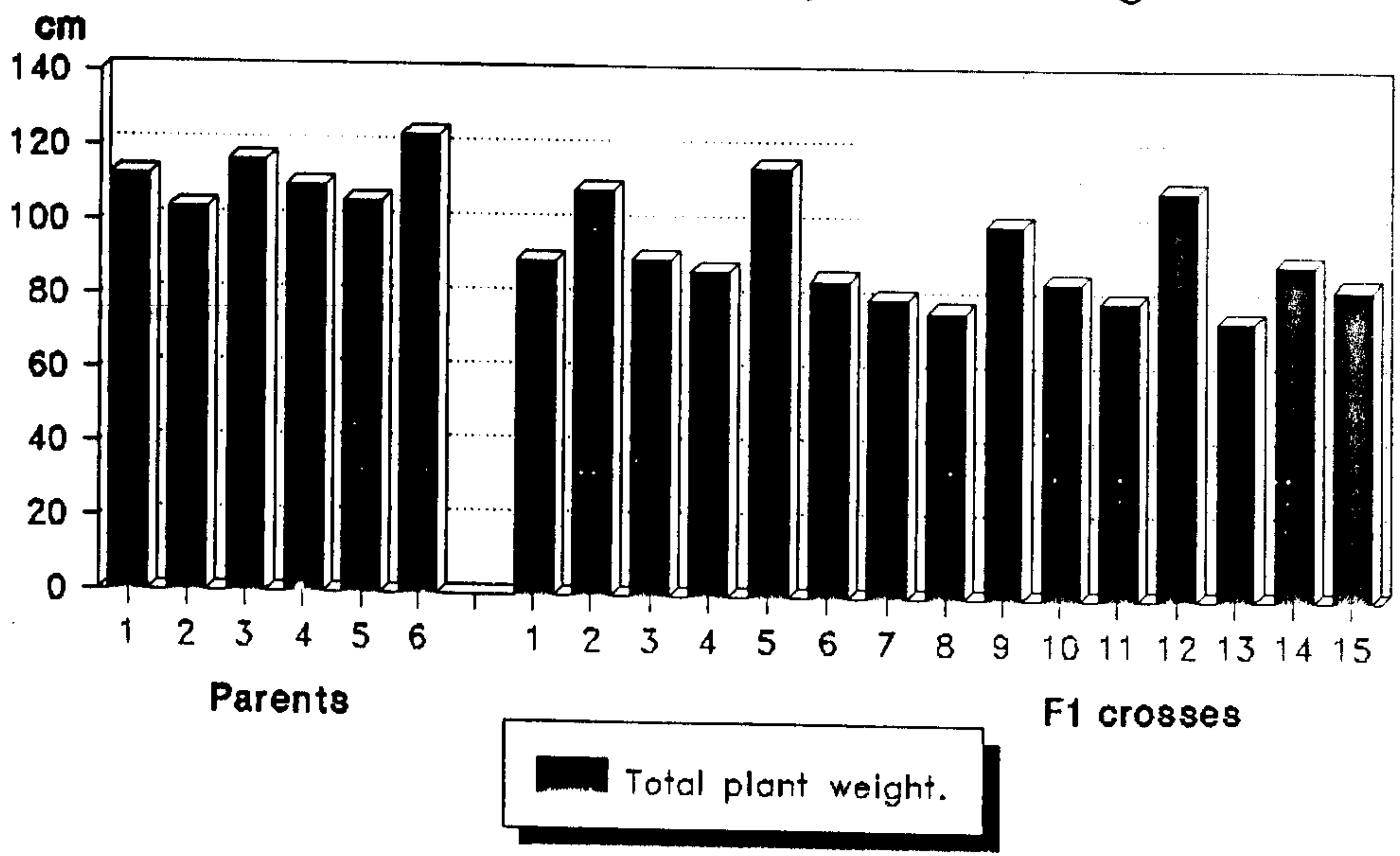
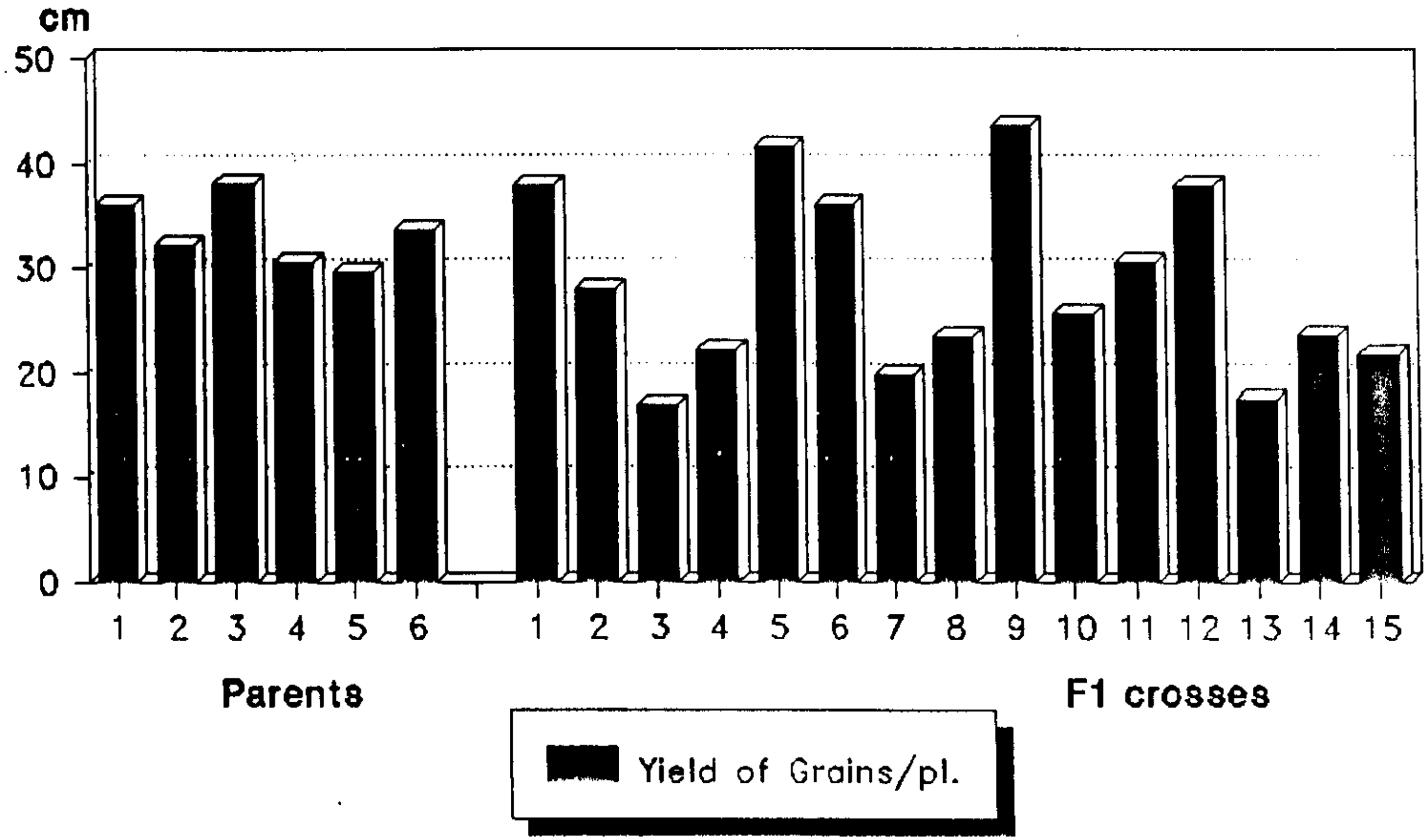


Fig (10): Mean of six wheat varieties and their F1 hybrids from a half diallel cross for Yield of grains per plant.



(1988), Mady (1988), Alkadoussi and Hassan (1991) and Hamada (1993).

Crosses involving P_1 and P_3 tended to have higher spikes number, while the crosses involving P_2 and P_5 showed the reverse.

For spike length per plant character, all crosses; 1x2, 1x3, 1x4, 1x5, 1x6, 2x3, 2x4, 2x5, 2x6, 3x4, 3x5, 3x6, 4x5, 4x6 and 5x6 exhibited significant negative heterotic effect as compared to the longer parent (- 0.79 to - 33.62). Significant positive heterosis relative to better parent were recorded by *Attia, 1972; El-Shamarka (1980), Mitkess; 1981, Mosaad et al., Alkadoussi and Hassan (1991) and Hamada (1993).*

Concerning number of spikelets per spike, the four hybrids 1x3, 2x3, 2x6 and 3x6 revealed significant positive heterosis relative to better parent. The values ranged from 1.14 to 2.44. While the rest of hybrids showed significant negative heterosis i.e 1x2, 1x4, 1x5, 1x6, 2x4, 2x5, 3x4, 3x5, 4x6 and 5x6 ranging from -0.71 to - 17.60 comparing to the better parents. *Abd-El-Halim (1974)* recorded that number of spikelets pe spike gave lower hybrid vigour. While *Mitkess (1981)* found significant negative heterosis for number of spikelets per spike.

The hybrids 1x2, 1x4, 1x6, 2x6 and 3x6 showed significant positive heterotic effect concerning number of kernels per spike. *Abd-*

El-Halim (1974), Mitkees (1981) and Hamada (1993) obtained similar results.

While the hybrids, P_1 x P_3, P_1 x P_5, P_2 x P_3, P_2 x P_4, P_2 x P_5, P_3 x P_4, P_3 x P_5, P_4 x P_6 and P_5 x P_6 showed significant negative heterosis ranged from - 13.16 to - 0.04% (Table 10). Many investigators revealed that F_1 hybrids equal or significantly have negative heterotic effects (*Winder and Lebscok, 1973 and Mani and Rao, 1977).*

The data of 1000-kernel weight per plant showed that four crosses have significant positive heterotic effects comparing to the better parent value. These crosses are P_1 x P_6, P^2 x P_3 , P_3 x P_6 and P_4 x P_5 and with the positive values ranged from 8.08% to 16.42%. Adversely, the other crosses expressed negative heterois in a range of - 25.22% to - 0.62%. The positive heterosis relative to better parent was also recorded by *Winder and Lebscok (1973), Abd-El-Halim (1974), Karrar (1981), Mitkees (1981), Bhatti et al. (1982), Mahdy (1988), Xu (1988), Younis 1988, Alkaddoussi and Hassan (1991) and Hamada (1992).*

For total plant weight, all F_1 crosses showed significant negative heterotic effects in a range of -32.11 to -6.38 for P_5 x P_6 and P_1 x P_3 comparing to their better parents, *Tamam (1989) and Hamada (1993).*

Four hybrids significantly over yielded their better parents with 5.30% to 29.23%. The crosses are P_1 x P_2, P_1 x P_6, P_2 x P_5 and P_2 x P_6. These hybrids showed heterosis for one or more of characters contributing yield. Positive heterosis for better yielding parents were reported by *Attia (1972), Bitzer and Fu (1972), Winder and Lebsock (1973), Abd-El-Halim (1974). Ageez (1976). Eisea (1976), Mani and Rao (1977), Gill et al. (1979), El-Shamarka (1980), Karrar (1980), Bhatti et al. (1982), Singh et al. (1984), Gautam and Jain (1985), Sharma et al. (1986) and Redhu et al. (1987),* the other hybrids showed negative heterotic effects in a range of - 53.20 to - 0.68 in P_1 x P_4 , P_3 x P_4, and P_4 x P_6. These hybrids are P_1 x P_3, P_1 x P_4, P_1 x P_5, P_2 x P_3, P_3 x P_4, P_3 x P_5, P^3 x P_6. Similar results were reported by *Dhonuskshe and Rao (1979), El-Khateeb (1990), Xu (1988), Younis et al. (1988), Hendawy (1989) and Hamada (1993).*

II. Combining ability:

Analysis of variance for combining ability (Table 8) revealed that mean squares due to General and specific combining ability were significantly detected for all characters. High ratios which exceeded the unity were obtained for all characters, revealing that the great part of the total genetic variability resulted from additive and additive x additive types of gene action.

In self pollinated crops such wheat, the main goal for breeding wheat is to determine and isolate the parental combinations that are likely to produce desirable homozygous segregates. In this investigation, the additive genetic variance which is superior for most studied characters may be exploited for improvement of these characters through conventional breeding procedures.

II.1 General combining ability effects:

Estimates of general combining ability effects ($g^{\wedge}_{1}$) for parents in each character are found in Table (11). General combining ability effects for parents estimated herein showed significant differences from zero in many characters (Table 12). Negative values are considered very important especially for heading date to escape from rust diseases and high temperature at late season. For plant height character, shortness is needed to avoid lodging and high nitrogen response. Positive values would be of great interest for most characters especially yield and yield components.

For heading date, Pavon, Giza 157, city straws and Mario showed significantly negative general combining ability revealing that these parents could be considered as good combiners for earliness. Pavon had larger value which differed significantly from the corresponding values in the other parents.

Mario, Pavon and Giza 157 showed significant negative general combining ability effects for plant height suggesting the possibility of using these variet^@ s to release short varieties. Hatry, floranae and city straws showed positive values in which breeding for tallness is more likely.

For number of tillers per plant, floranae, Hatry and Mario showed significant positive general ability effect for high tillering ability. Negative values were detected by Pavon and Giza 157 for number of tillers per plant.

Mario and Hatry show d significant positive general combining ability effect for large number of spikes per plant. Therefore, these parents could be used for breeding for increased spikes per plant.

Mario, Pavon and city straws showed significantly positive general combining ability effects for spike length while Hatry, floranae and Giza 157 produce short spikes.

Mario, Giza 157, Pavon and City straws. showed significant positive general combining ability effects for number of spikelets per spike, Whereas Hatry and Floranae showed significantly negative general combining ability effects for the same character.

Giza 157, Mario and City straws revealed that highly positive significance for number of kernels per spikes meanwhile negative general combining ability effects were detected for Hatry, Floranae and Pavon.

For 1000-kernel weight, significant positive effects were obtained for City straws, Mario and Giza 157. The three parents were considered as the best combiners for heavy kernel weight.

Mario, Giza 157 and City straws showed significantly positive general combining ability for total plant weight. The other parents showed significantly negative general combining ability.

Mario, City straws, Pavon and Giza 157 seemed to be good combiners for grain yield per plant. Mario and City straws 3.354 and 3.169 showed the highest effect for combining ability while floranae appeared to be the lowest combinor (-4.261).

Grain and other yield components were much judged by general combining ability effects as mentioned by *Bhatt (1971), Winder and Lebsock (1973), Abd-El-Halim (1974), Ageez (1976), Eisea (1976), Mani and Rao (1977), Khalil et al. (1979), El-Shamarka (1980), Mitkees (1981), and Sharma et al. (1986)*. On the other hand *Abd-El-Halim (1974) and Sharma et al. (1986)* recorded insignificant general combining ability effects for number of spikes per plant, spike length and grain yield.

It can be concluded that the parent which had high general combining ability effects for grain yield may show the same effect for one or more of the characters contributing to grain yield. For instance, Mario, City straws and Giza 157 exhibited the highest positive effects for grain yield and number of spikelets per spike, number of kernels per spike, 1000-kernel weight and total plant weight. These results in agreements with those concluded by *Eisea (1976), El-Shamarka (1980), Yadav et al. (1987), Zubair et al. (1987), Bhullar et al. (1988) Kasium and Mubarak (1989), Shripol and Singh (1990) Alkaddoussi and Hassan (1991), Ikram and Tanach (1991), Salem and Hassan (1991) and Hamada (1993).*

II.2. Specific combining ability effects:

Estimates of specific combining ability effects are found in Table (10).For heading date character, eight combinations showed significantly negative combining ability effects. The crosses P_1 x P_2, P_1 x P_6 , P_2 x P_3 and P_4 x P_5 had the lowest values revealing that they are the best populations for selection for earliness. Moreover, estimates of specific combining ability were significantly and positively correlated with heterosis (0.729), Table (11), revealing the importance of non-additive genetic action and the ability to search for heterosis through highly specific combining ability crosses. These results agreed with the value of 16.97 for GCA/SCA ratio, (Table 8) which indicates the prevalence of additive gene action but not omitting the importance of non-additive type. General and specific combining ability effects were revealed by *Bhatt (1971), Hamma (1973), Ageez (1976), Barakat and Aksel (1976), Mani and Rao (1977).* **The utilizing of both types in number of crosses would promise successful production of early lines or hybrids.**

Three hybrids showed significantly negative specific combining ability effects for plant height. on other hand, eight hybrids showed significant positive effects. The positive effects agreed mostly with the respective heterotic effects, estimated before, and the significant correlation between estimates showing the importance of non-additive genetic action (Table 11). While the negative effects might be resulted from additive genes with minor effects that could not produce heterosis toward shortness. The value 6.34 of GCA/SCA ratio revealed that non-additive genetic action operating in this trait is less important than the additive type. *Attia (1972), Abd El-Halim (1974), Mani and Rao (1977), Khalil et al. (1979), Karrar(1980) and Mitkess (1981)* showed that most of the genetic variability to general combining ability i.e additive effects. However this results explained the possibility of obtaining either short or tall varieties through utilizing the non-additive effects (those expressed in heterosis), it may be more successful to breed for them by utilizing suitable combiners.

Regarding the tillering ability per plant, Specific combining ability with significant positive values were recorded in three crosses; $P_2 \times P_5$, $P_2 \times P_6$ and $P_3 \times P_4$, (Table 10). It showed positive correlation with heterosis (Table 11). These results reveal the importance of specific combining ability in determination of heterosis, which is based on non-additive gene action.

Concerning yield components, significantly positive specific combining ability effects were found in five, one, two, six and three crosses, for number of spikes per plant, spike length, number of spikelets per spike, number of kernels per spike and 100 kernel weight per plant, respectively (Table 10). All values revealed positive correlation with heterosis; 0.818, 0.804, 0.950, 0.863 and 0.718, respectively (Table 11). The results explained the importance of specific combining ability in determination of heterosis, which is depend on also non-additive gene action. Weight of 1000 kernels per plant seemed to be the least efficient indicator which may attributed to higher environmental effects. Number of kernels per spike and its related characters; number of spikes per plant, spike length and number of spikelets per spike is more effective through selection criteria for increased yield. The crosses P_1 x P_2, P_1 x P_5, P_1 x P_6, P_3 x P_4 and P_3 x P_6 showed significant specific combining ability effects for at least two of yield components and mostly for total yield per pant. P_1 x P_2, P_1 x P_6 and P_3 x P_6 showed also positive heterosis in two of yield components and in total grain yield per plant except P_3 x P_6. This indicate that specific combining ability may be used as an indicator for heterosis. *Bhatt (1971), Abd-El-Halim (1974), Mani and Rao (1977), Karrar (1980), Mitkees (1981) Ranvir-singh et al. (1983) and Maloo*

(1987) found that both general and specific combining ability effects for yield components, being mostly due to general effects.

Total plant weight showed significant specific combining ability in three crosses; P_1 x P_3, P_1 x P_6 and P_3 x P_6. Correlation between heterosis and specific combining ability values was (0.952), Table (11), also revealed the importance of non-additive effects for heterosis in this trait.

Concerning the grain yield, five crosses showed significantly positive specific combining ability effects Table (10). Three crosses of them showed significantly positive heterosis, revealing the importance of non-additive gene action for heterosis expression. Correlation between specific combining ability and heterosis (0.928) are found in table (11) ensured this explanation Crosses P_1 x P_2, P_1 x P_6 and P_2 x P_6 had the highest values of specific combining ability, to be useful in establishment of hybrid varieties. However, hybrids with high specific combining ability effects in grain yield seemed no to had it for other components, but correlation study showed positive relationship between heterosis or specific combining ability values of grain yield per plant and any value of the other components. It was found that a strong relationship between grain yield and 1000-kennel weight per plant and number of kernels per spike or its related characters, but the relationship was weak with spike number per plant Table (12). So, we can utilize heterosis or specific combining ability effects of the first two components to exhibit high heterosis or specific combining in grain yield. *Bhatt (1971), Walton (1971), Winder and Lebsock (1973)* showed that the main part of the total genetic variance for grain yield was due to additive effect; i.e general combining ability.

IV Correlation coefficients:

Parents and F_1 hybrids mean values were used to get simple correlating coefficients among days to heading, plant height number of tillers per plant spike length, number of spikes per plant, number of spikelets per spike, number of kernels per spike, 1000-kernel weight, total plant weight and grain yield. The values estimated at three parts: phenotypic(rp), genotypic (rg) and environmental (re), (Table 12).

It was found that phenotypic and genotypic correlation coefficients were higher than the environmental ones indicating that the expression of these characters depends on the genetic constitution with little or neglected environmental effects.

Moreover, genotypic correlation values were higher than the phenotypic correlation values in all cases. Also, it was found that both types were similar in signs, indicating that significant phenotypic correlations were mainly due to genetic causes. *Karrar (1980)* supported this result.

Heading date showed significantly negative correlation with spike length per plant, spikelets number per spike, grain number per spike, 1000 kernel weight per plant and grain yield per plant at both genotypic and phenotypic levels. on the other and it showed significantly positive correlation with spike number per plant and tillering ability per plant. *Randhawa and Gill (1978), Karrar (1980), Nada et al. (1980) and El-Showny et al. (1987)* revealed that heading date was a negative correlation with grain yield. This indicated that, it is difficult to obtain high yielding genotypes with early heading.

There is positive significant correlation between plant height and tillering ability per plant and heading date. Significantly negative correlation was detected between plant height and each of spike length, spikelets number, grain number per plant, 1000 kennel weight per plant, total plant weight and grain yield per plant. No significant variation could be detected between plant height and spike number per plant. This indicates that the possibility of breeding high yielding varieties with either tall or short stems. *Fatsra and Paroda (1980), Nanda et al. (1980) and El-Showy et al. 1987* showed positive correlation with grain yield and one or more of its components, while *Karrar (1980)* found negative correlations.

Significantly, positive correlations were found between spike length and each of grain number per spike, spikelets number per spike, 1000-kernel weight, total plant weight, and grain yield per plant

Negative correlations were detected between spike length and tillering number per plant, heading date and planting height. No significant relation was observed between spike length per plant and spike number per plant. So, selection for long spike may result in increased grain yield through increasing number of kernels per spike with significant effect on 1000-kernel height.

Non-significant positive phenotypic and genotypic correlations was found between number of spikes per plant and spike length per plant, grain number per plant, tillering ability per plant, 1000 kernel weight/plant, total plant weight, heading date and plant height. Non-significant negative correlation was found between spike number per plant and grain yield per plant and spikelets number per plant. This revealed that increased number of spikes per plant was associated with increase of kernels per spike and 1000 kernel weight per plant. Similar results were observed by *Nanda et al. (1980), Cammack (1984), El-Shouny et al. (1937) and El-Khatib (1990).*

Significant positive phenotypic and genotypic correlations were obtained between number of spikelets per spike and each of spike length , grain yield per plant, 1000-kernel wight , total plant weight and grain yield per plant. Significant negative phenotypic and genotypic correlations were observed between spikelets number and heading date, plant height, tillering ability and spike number per plant. These results were supported by the findings obtained by *Gupta et al. (1989),* *El-Shouny et al. (1987) and El-Khatib (1990).*

Concerning number of kernels per spike, significant positive correlations were detected with each of spike number per plant, spike length per plant, 1000 kernel weight per plant, total plant weight and the grain yield per plant. Significant negative correlations were found between number of kernels per spike and heading date, plant height and tillering ability. Similar results were detected by *Karrar (1980), Randhawa and Gill (1980), Sip et al. (1980), Cammack (1984), El-Shouny et al. (1987) and El-Khatib (1990).*

Significant positive correlations at genotypic and phenotypic levels were found between 1000-kernel weight per plant and number of spikes per plant, spike length spikelets number per spike, grain number per spike, total plant yield and grain yield per plant. Significant negative correlations were detected between (1000-kernel weight and heading date, plant height and tillering ability. Similar results were obtained by *Gupta et al. (1979), Karrar (1980), and El-Khatib (1990).*

Concerning Total plant weight exhibits significant positive correlation with number of spikes per plant, spike length, spikelets number per spike, grain number per plant, 1000 kernel weight per plant and grain yield per plant. The other characters showed negative correlations with the total plant weight.

Significant positive phenotypic and genotypic correlations coefficients were detected between grain yield per plant and each of spike length per plant, spikelets number per plant, grain number of plant, 1000 kernel weight per plant and total plant weight.

Therefore, selection for higher yield ability may be attained through one or more of the following characters *(El-Khatib (1990)*.

Spike length, number of spikes per plant, number of spikelets per spike and number of kernel per spike. Table (11): Correlations between specific combining ability and better parent heterosis.

Table (11): Correlations between specific combining ability and better parent heterosis.

Character	r
1. Heading	0.729
2. Plant height	0.508
3. No. of tillers per plant	0.485
4. No of spikes per plant	0.818
5. Spike length per plant	0.804
6. No. of spikelets per spike	0.950
7. No. of kernels per spike	0.863
8. 1000 kernel weight	0.718
9. Total plant weight	0.952
10. Yield per plant	0.928

** and * : Significantly different at probability level of 0.05 and 0.01, respectively.

Table (12): Genotypic (Gr), phenotypic (Pr) and Environmental (Vr) correlation coefficient for the studied characte 5.

Characters / Genotypes		Plant Hei-ght	Number of Ti-llers	No. of Spikes /plant	Spike length cm	No. of Spikel /spike	No. of Kernels per Sp.	1000 Kernel Weight	Total plant weight	Yield grains per pl
Heading date	G	0.650	0.723	0.115	-0.434	-0.495	-0.484	-0.468	-0.157	-0.570
	P	0.646	0.707	0.113	-0.426	-0.490	-0.474	-0.463	-0.156	-0.567
	E	-0.132	0.056	-0.046	-0.201	0.000	0.175	0.022	0.073	0.000
Plant height	G		0.626	0.101	-0.684	-0.772	-0.544	-0.290	-0.653	-0.765
	P		0.612	0.101	-0.665	-0.764	-0.536	-0.287	-0.651	-0.762
	E		0.026	0.000	0.223	0.201	-0.065	0.140	0.101	0.060
Number of Tillers	G			0.135	-0.117	-0.436	-0.311	-0.060	-0.255	-0.345
	P			0.132	-0.180	-0.428	-0.305	-0.058	0.272	-0.338
	E			0.036	-0.125	0.170	0.137	0.017	0.255	-0.076
Number of Spikes/p	G				0.089	-0.117	0.297	0.215	0.255	-0.091
	P				0.088	-0.115	0.289	0.206	0.252	-0.091
	E				0.052	0.000	-0.045	-0.334	-0.047	-0.083
Spike length	G					0.625	0.390	0.578	0.576	0.594
	P					0.607	0.375	0.566	0.564	0.582
	E					0.000	-0.040	0.200	0.164	0.146
Number of Spikelets	G						0.675	0.353	0.638	0.776
	P						0.662	0.348	0.633	0.769
	E						0.000	0.000	0.000	0.099
Number of Kernels/p	G							0.556	0.593	0.758
	P							0.544	0.584	0.747
	E							-0.043	-0.286	0.000
1000-Kernel weight	G								0.346	0.513
	P								0.343	0.510
	E								0.022	0.157
Total plant weight	G									0.641
	P									0.638
	E									-0.264

** and * : Significantly differed at probability level at 0.05 and 0.01, respectively.

Summary

The aim of this research is to study the heterosis, combining ability and correlations for yield and its components beside heading date,plant height and tillering ability in wheat. In this study, sex parental genotypes from different origins were used as the following:

1. Giza 157 2. Pavon 3.City straws

4. Hatry 5. Floranae 6.Mario

The above-mentioned genotypes were used in a diallel cross during 1989/1990 and 1990/1991 seasons at the agricultural research station ,Moshtohor.

Hybrid vigour were estimated as a percentage of F1 deviation in comparison to the better parent. General and specific combining ability were estimated according to "Griffing" in addition to Phenotypic, Genotypic and environmental correlation coefficients.

Results can summarized as the following :-

1. Means:

Pavon was the best genotype for heading date, and had the lowest number of tillers, spikelets number , grain number per spike and the total plant weight.

On the other hand, Hatry was the latest one for the heading date and the largest in plant height and had the lowest number of 1000 kernel weight.

Floranae had a good tillering ability, and less spike length and less grain yield per plant.

City straws was the best one for 1000 kernel weight and for the grain number per spike beside the grain yield per plant.

Giza 157 was the best for number of spikelets per spike and to some extent in grain number per spike and grain yield per plant.

Mario was found to be the biggest for spike number per plant, spike length and the total plant weight.

2. Heterosis:

Heterosis was appeared in some crosses in a range from -1.13 % to 5.89 % for heading date and from 0.46 to 7.17 % for plant height and from 7.96 to 12.55 % for number of tillers per plant and from 5.19 to 16.48 % for spike number per plant and it showed negative heterosis in case of spike length. From 1.14 to 2.44 were observed for spikelets number per spike and from 8.08 to 16.42 % for the 1000-kernel weight per plant and from 5.30 to 29.23 % for grain yield per plant.

3. Combining ability:-

The best varieties for general combining ability were:-

Pavon, Giza 157, City Straws and Mario for Flowering Date.

Mario, Pavon, Giza 157 for Shorter for stem.

Hatry, Floranae and City Straws for 1000- kernel weight.

City Strawes, Giza 157 and Mario for the Yield weight per parent.

All the studied characters showed highly significant specific combining ability either in Positive or in negative change. The correlation between hybrid vigour and Specific combining ability showed highly positive significant differences for all the studied characters which revealed the superior effect for gene action for hybrid vigour and specific combining ability.

4.Correlation:

The correlation results revealed the following :-

Flowering date showed significantly negative genotypic . and phenotypic correlation with the plant yield, Spike length , Kernel Number. Number of spikelets per spike, 1000- Kernel weight and the total plant weight. It revealed significantly positive genotypic and phenotypic correlation with spike number , Tillering ability and plant height.

Plant height revealed significantly negative genotypic and phenotypic correlation with yield , Spike length, kernel number, Spikelets number per spike, 1000- kernel weight and the total plant weight. At the sametime, It showed positively significant and genotypic and phenotypic correlation with spike length, tillering ability and Flowering date.

Tillering ability character revealed that significantly negative genotypic abd phenotypic correlation with yield , Spike length, Kernel number, Spikeletes number and the plant weight and at the sametime , it showed non-significant negative genotypic and phenotypic correlation for 1000- kernel weight. It showed also significant positive genotypic and phenotypic correlation toward the flowering date and plant height .

Number of spikes per plant revealed significant positive genotypic and phenotypic correlation with number of spikeletes and non- significant with yield It showed significantly positive genotypic and phenotypic correlation with number of tillering per plant, 1000 - kernel weight, total plant weight , flowering date and plant height and non - significant with the spike length.

The Spike length character showed significantly negative genotypic and phenotypic correlation with tillering ability, Flowering date and plant height. It showed non - significant correlation with the number of spikes per plant. IT revealed also significantly positive genotypic and combining ability.